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A STUDY IN TACTUAL LOCALIZATION IN A CASE PRESENTING ASTEREOGNOSIS AND ASYMBOLIA DUE TO INJURY TO THE CORTEX OF THE BRAIN.*

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James C., about 40 years of age, as the result of a blow from the corner of a carpenter's spirit level which fell upon his head, received a circumscribed compound fracture of the skull over the left parietal region. The wound was treated on modern surgical principles. After recovering from the immediate effects of the injury there remained a marked spastic paralysis of the right arm and a slight paralysis of the right leg not sufficient to prevent its use for ordinary purposes of locomotion. Beyond the condition of sensibility, to be presently described, and the location of the injury, there was nothing remarkable in the case.

Location of the injury: Over the parietal bone is a marked depression, slightly oval in shape and slightly larger than a quarter dollar. On mapping out on the cranium the fissure of Rolando, it is found that the center of this depression lies directly over the line of this fissure at about its middle third. This is shown in the accompanying photograph. It will thus

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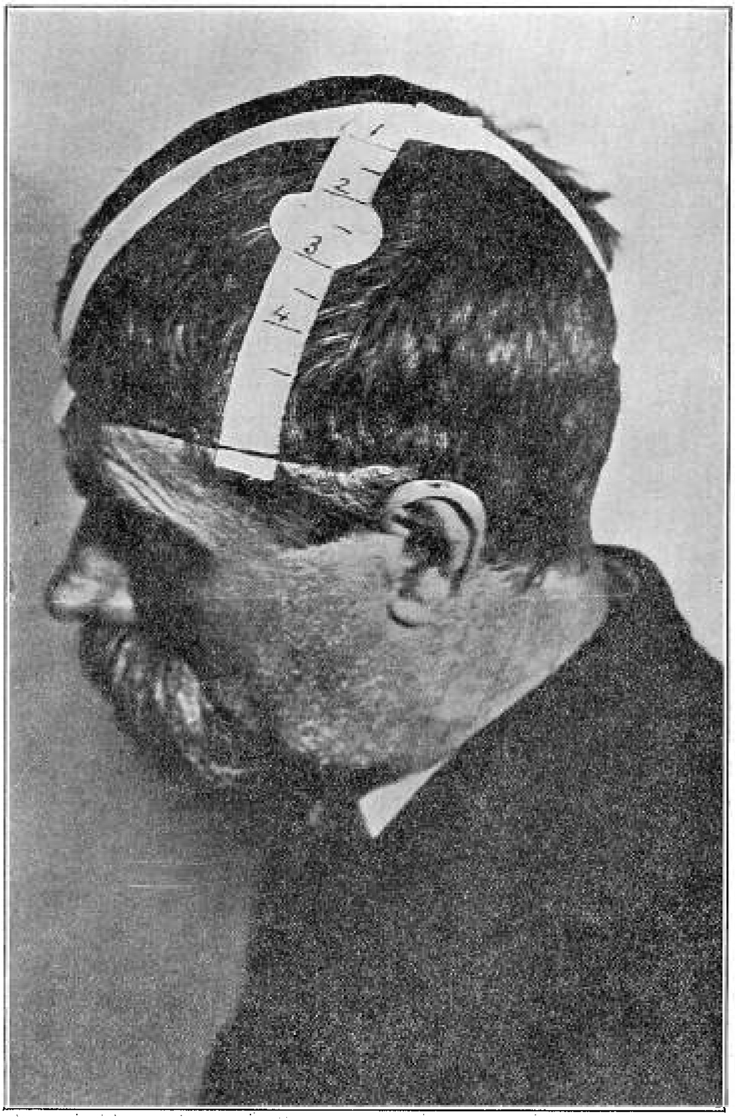

Fig. 1. Showing Location of Injury.

be seen that the depression corresponds very accurately with the arm center and with what should be the location of both the post and pre-central convolutions, and although in the absence of autopsy it is impossible to determine the extent of the underlying cortical lesion, yet the character of the blow was not such as to cause an injury of wider extent.

Sensibility: The tactile sense was found to be absolutely unimpaired in the affected right hand. This sense was tested by the von Frey method; that is, by means of single hairs of different stiffness and also with the camel's hair brush and cotton wool. No difference whatsoever between the sense of tactile sensibility in the normal left hand and affected right hand could be recognized. The slightest touch that could be perceived in one hand could be perceived in the other, and the patient himself could recognize no difference in the tactile perceptions whether tested by a single hair or by the other tests.

Temperature sense tested by test tubes filled with warm and cold water, and pain sense tested by the prick of a pin were also found to be normal in the affected hand.

Bone conduction tested by the tuning fork was rather better appreciated in the affected hand than in the normal hand.

Pressure sense was tested to determine qualitative but not quantitative difference in the two hands. For this purpose, objects of different weights were placed on the palmar surface of the fingers and on the palms, and pressure was exerted by the examining finger. There was found to be a very marked difference between the two hands as shown for instance by the fact that an iron paper weight weighing approximately two pounds pressing by one corner on a circumscribed spot, felt light to the right affected hand, but heavy to the left hand. Pressure exerted by the examining finger until it was forcibly hyper-extended over the dorsal of the phalanx was not felt more forcibly than very light pressure similarly applied to a corresponding spot on the left hand.

Perception of posture of the fingers was practically lost. They could be flexed, extended, abducted and adducted, at the different joints without the patient being aware of the position which the fingers assumed. In fact, the patient said with his eyes shut he had no idea where his fingers were. The wrist, elbow and shoulder joints were similarly affected, but to a less degree than the fingers. The impairment of perception of posture of these joints diminished in intensity as one proceeded proximally to the shoulder joint, which was only slightly affected in this respect.

The perception of movement and direction of movement was also much impaired. Quantitative measurements showed that any movement under approximately ten degrees was not felt at all; when movement was extensive enough to be appreciated direction of movement was not recognized at all.

Localization: Two methods of testing were employed; First, the "naming" test; that is, directing the patient to name the finger, or segment of the finger, touched with a camel's hair brush or pencil point while the eyes were closed. Second, the Volkmann method, or so-called "looking procedure" (Spearman). This consists of touching a spot on the skin with a pointed object while the patient's eyes are closed; then, after waiting a second or so for the indented skin to resume its normal appearance, having the patient open his eyes and point out the exact spot touched. (It was found that Weber's or the "groping" [Spearman] test was inapplicable as the patient having lost all sense of position of his hand did not know, with his eyes closed, where it was. The method consists in having the patient point out the spot touched while his eyes are closed.)

In the first series of experiments the tests were applied to the palmar surface. By the two tests employed, the "naming" and "looking" tests, it was found that by both tests there was great loss of perception of localization over both surfaces of the fingers, and to a less degree over the palm of the hand. The patient by the naming test as often as not did not know which finger was touched or which segment of a finger, but as will be described later in connection with a third series of tests, localization by the "looking" test was more accurate than by the "naming" test, particularly in regard to the segmental error, even when the wrong finger was pointed out.

About two weeks later, March 6, after there had been considerable improvement in sensibility, the perception of localization was tested by the spacial method, often wrongly called a test of the "spacing sense." There are two methods: the one is the compass method by which two points are touched at the same moment; the other consists in touching the two points successively instead of contemporaneously. (It is generally overlooked that the recognition of two points contemporaneously does not necessarily mean the recognition of the separation of those points.) The second method was employed, the subject being directed to say whether the point touched was nearer the shoulder or tip of the finger. By this method it was found at this time that the recognition of the perception of localization was still not as good on the palmar surface of the right hand as on the left. He was still unable to recognize form or the nature of objects.

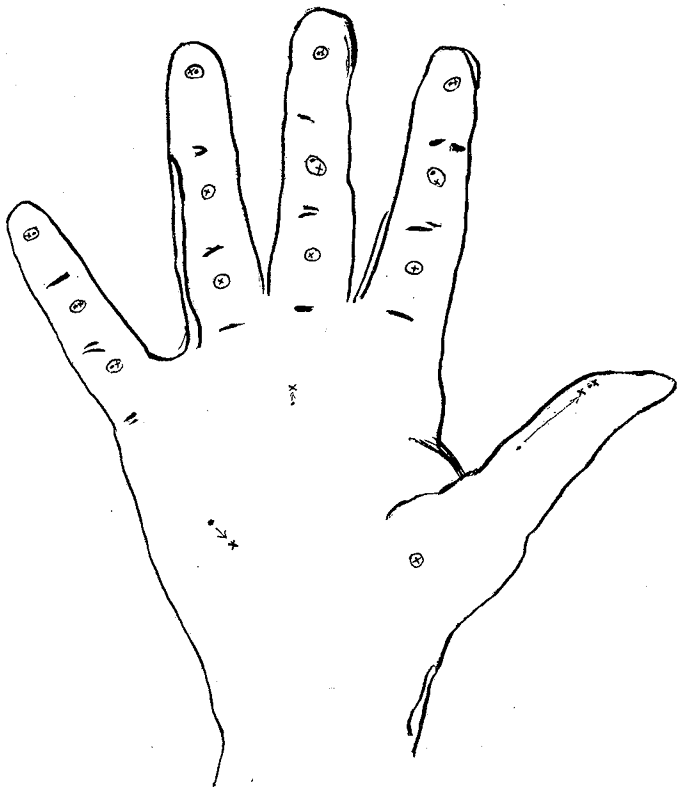

Fig. 2. March 22. After improvement; palmar surface; details same as in diagram of dorsum. Localization by the Volkmann method practically normal. By the "naming" test on this date patient often could not localize correctly segment or finger.

The condition of sensibility in the hand continued to improve and it was found two weeks later (March 22) that the perception of localization over the palmar surface of the hand, tested by the Volkmann ("looking") procedure, was practically normal. (See Fig. 2.) On the dorsum of the hand,

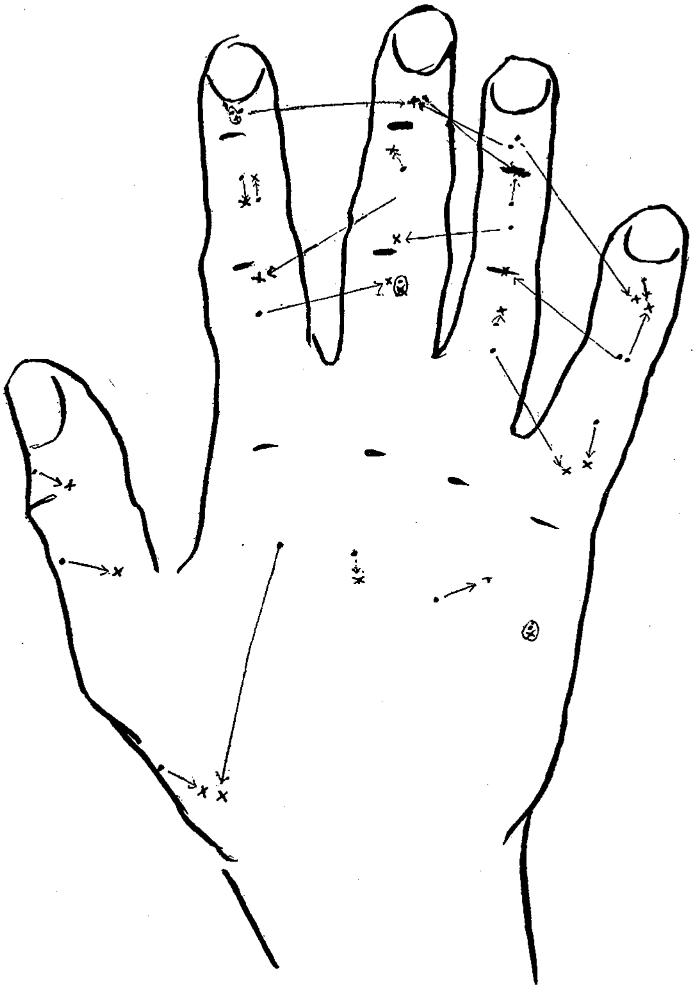

Fig. 3. March 22. After improvement. Localization by the Volkmann method, dorsum of hand; dots = test points; x = localization by subject; arrows = direction of error; circles = correct localization within normal limits.

however, there continued to be marked errors in localization but errors were post-axial and pre-axial rather than segmental, although there were some segmental errors. (See Fig. 3.) That is to say, it was the wrong finger rather than the wrong segment that was localized. When the "naming" (eyes screened) test was employed, results that were widely divergent from these were obtained. Now on the palmar surface of the hand, where the patient by the previous (Volkmann) test was able to localize normally, there were numerous errors in localization both as respects the finger touched and the segment, and the errors were nearly as numerous and extensive as on the back of the hand where by the "looking" procedure, as above stated, there had been marked axial errors. On this (dorsal) surface of the hand the errors now by the "naming" test were also segmental. Further the localization of the correct finger on the palmar surface was better than on the back, but the segmental errors were quite as numerous as on the back.

I would emphasize here the importance of these results as showing the influence of the form of the test in determining the presence of the loss of the perception of localization. A patient may be able to localize by one test and not by another, according to the kind of sensibility that is impaired;[1] that is to say, whether it is sensibility of the impressions from the joints, skin, movements, etc. The recognition of this fact acquires particular importance in the study of asymbolia and astereognosis. Tactual localization plays a very large part in the judgments involved in the perceptions of form, stereognosis) and recognition of objects (symbolia). That the capacity to make these judgments may be lost, although simple tactile sensibility is retained as in the above case, is well known, but the failure to recognize the fact that localization may be impaired when tested in one way and not when tested in another has led, it would appear, to the error of postulating stereognosis and symbolia as specialized faculties or "senses," rather than as intellectual judgments of the tactual impressions on which they depend, and localizing them in special regions of the cortex. Before such a conception can be entertained entire freedom from defects of the tactual senses essential for such judgments must be shown. But the proof of such freedom depends upon the tests employed. Different tests are required according to the kind of tactual defect present. At one stage in the above case, while astereognosis and asymbolia were present, localization by the Volkmann test on the palmar surface was normal, but by the "naming" test (with the eyes closed, *i.e.*, the condition essential for the test of the recognition of form and objects) there was marked defect of localization.

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[1] For a thorough analysis of the fundamental conditions underlying localization compare "Localization in a case of Brown-Séquard paralysis," C. Spearman. British Jr. of Psychology, January, 1905.

Perception of form (tactual stereognosis) and of objects (tactual symbolia): The patient was unable at all periods to recognize form of any kind. Not being able to designate whether small objects, like a pencil and coin, or large objects, like a blackboard eraser and pin-cushion, were long and narrow, round and flat, large or small, he had absolutely no idea of the shape. He was, therefore, unable to recognize and name them. In all these experiments control tests were made with the sound left hand. It was found, for instance, with this hand, that he could recognize the slightest motion given to the fingers both in direction and extent, and he could recognize form and shape and name any objects with which he was familiar.

It will thus be seen that the location of the bone lesion is entirely in accordance with the view of Campbell that the various sensibilities making up the so-called muscular sense have their location in the posterior half of the post-central gyrus, but not with his view that the tactile, pain and thermal senses are located in the anterior half. In this connection it must be kept in mind that while Campbell brings forward evidence to show that the post-central convolution is sensory, this evidence does not, as he fails to see, bear upon the character of the sensory functions here located, *i.e.*, whether they are tactile or so-called "muscular" senses, etc.

Foot: The results of the examination of the foot will be referred to in a subsequent paper on astereognosis and asymbolia. I will here merely state that no distinguishable difference in the tactile sense was discoverable between the perception of the right foot and of the left. Localization was only slightly affected, but more on the dorsal than on the plantar surface.

Experiments were now made to test the direction of the segmental error in the perception of localization. It will be remembered that Russell and Horsley have maintained that in errors of localization the error is always proximal and not distal; that is to say, the patient always locates the sensation in the segment nearer the root of the limb rather than in the more peripheral segment. Yet the authors referred to record, by the way, two observations where the error was in the distal direction. The results in my case did not confirm these findings; on the contrary, the error in the great majority of cases (in every instance but one) was distal, excepting that in five instances where the last phalanx was touched the error, if any, was necessarily proximal. The results of the tests in detail will be seen in the following table. (Those giving the finger alone without the segment are a few illustrative of the many that were made.) It will be seen that the segmental error was distal in fourteen instances, proximal in six, and in five of these six it was the last phalanx that was tested. Therefore, as I have said, the error in these five, if any, was necessarily proximal.

"NAMING" TEST

PALM OF THE HAND

Finger touched (Eyes closed, or screened)	Answer
Thumb	Middle finger
Fore finger	Fore "
Little "	Middle "

BACK OF HAND

Ring finger	Middle finger
Fore "	Fore "
Fore "	Middle "
Fore finger	Little "
Little "	Could not tell
Ring "	Little finger

BACK OF HAND

(Eyes open, but screened)

Ring finger	Don't know
Fore "	Fore finger
Ring "	Ring "

BACK OF THE HAND

Finger and segment touched (Eyes open, but screened)	Answer	Direction of error
Little 1st phalanx	Don't know	....
Fore 3rd "	Fore 1st phalanx*	Proximal
Middle 2nd "	Middle 1st "	Proximal
Ring 2nd "	Middle 3rd "	Distal
Thumb 1st "	Thumb 1st " but more distal	Distal
Thumb 2nd "	Thumb 2nd phalanx	....
Ring 2nd "	Fore 2nd "	....
Ring 3rd "	Fore 2nd " *	Proximal
Ring 2nd "	Middle 2nd "	....
Ring 1st "	Middle 3rd "	Distal
Little 1st "	Ring, between 2nd and 3rd	Distal
Fore 1st "	Fore 2nd phalanx	Distal
Middle 3rd "	Middle 3rd more distal	Distal
Ring 3rd "	Ring 3rd phalanx	....
Fore 3rd "	Fore 3rd "	....
Fore 3rd "	Ring 2nd " *	Proximal
Fore 3rd "	Ring 2nd " *	Proximal
Fore 2nd "	Ring 2nd "	....
Fore 1st "	Fore 1st "	....

PALM OF THE HAND

Middle 2nd phalanx	Middle 3rd phalanx	Distal
Ring 1st "	Ring 3rd "	Distal
Little 1st "	Ring 3rd "	Distal
Fore 1st "	Fore 3rd "	Distal
Thumb 3rd "	Thumb 3rd "	....
Ring 3rd "	Ring 3rd "	....
Fore 1st "	Fore 2nd "	Distal
Fore 2nd "	Fore 3rd "	Distal
Middle 2nd "	Middle 2nd "	....
Ring 2nd "	Fore 3rd "	Distal

Ring	2nd	phalanx	Middle	2nd	phalanx	....
Little	2nd	“	Ring	3rd	“	Distal
Little	3rd	“	Ring	2nd	“ *	Proximal
Ring	3rd	“	Ring	3rd	“	....
Fore	1st	“	Fore	1st	“	....
Thumb	3rd	“	Thumb	3rd	“	....

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*Error on the third phalanx necessarily had to be proximal.